Agriculture Net Zero Report

How we're helping our agricultural customers understand and adapt to climate change.

Virgin MONEY

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A few words from Brian Richardson

Helping farmers get to net zero

In recent years, the focus on climate change and how to deal with the challenge has increased greatly.

Agriculture has a key part to play in the UK's transition to a net zero economy. While farming contributes approximately 10% of the UK's carbon emissions, the significant land resource within the sector provides it with the opportunity to sequester more carbon than it emits. This gives agriculture a natural advantage in getting to net zero faster.

To help farmers become greener and more efficient, Virgin Money has launched the £200 million Agri E fund. This will provide funding on favourable terms, which can be used for investment in emission-reducing initiatives which aid productivity, subsidy schemes or supply chain initiatives, and the sequestration of greenhouse gases from the atmosphere.

The fund will also encourage the uptake of carbon audits, which are becoming increasingly important in agriculture's supply chain. A carbon audit produces a comprehensive report on a farm's carbon outputs, highlighting inefficiencies, and ways to do things differently, both to reduce costs and carbon emissions.

We're working closely with our farming customers to help them understand the challenges and make plans to reduce and sequester emissions on their own land. There's no one-size-fits-all solution. Some farmers will focus more on food production, while others will look at land use and concentrate on the environment.

Farmers have always shown they are good at adapting, once they're sure of their ground. That's why, to help us produce this report, we've partnered with Carbon Metrics, a consultancy which advises rural businesses on managing and auditing their emissions.

The purpose of this report is to help farmers understand the background to climate change, specifically relating to agriculture. We'll go through what it means for the industry, as well as how farmers can adapt to meet the challenges, and plan their own journey towards net zero.

Our team of Agricultural Managers are on hand to support our customers, and we welcome your feedback on this guide. Knowledge sharing and new tech will play a key part in achieving net zero, and we look forward to working with our customers, to help the industry deliver on the commitments it has already made.

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Introduction

Climate change is the number one long-term threat to the planet, and the need to understand, adapt to, and beat it has become an urgent one.

In 2019, levels of atmospheric carbon hit record highs[1]. The UK government responded by setting the ambitious target of net zero by 2050[2]. The Scottish Government soon followed suit with a target of 2045[3].

Meanwhile, the NFU set the agricultural sector its own target of net zero by 2040[4]. This sector holds a unique position in the journey towards net zero. That's because, as well as being a source of emissions, the countryside can also provide sinks (natural storage) for vast volumes of greenhouse gases – in its soil and forests, for example.

The UK agriculture and land-use sector accounts for around 10% of the UK's total greenhouse gas emissions[5]. However, it's different from other sectors, such as oil and gas, because its main emissions aren't of carbon. Currently, 56% are methane, 31% nitrous oxide, and only 13% carbon dioxide[6].

To reach the targets, the Committee on Climate Change has recommended a 64% reduction in greenhouse gas emissions[7]. As one of the biggest lenders to the UK agricultural sector, we understand the importance of helping our customers achieve that.

That's why we've put this report together, so we can:

- Introduce you to the key topics in the net zero discussion
- Outline the more technical and scientific elements of climate change
- Highlight areas of disagreement in current thinking
- Help you begin your net zero journey

Helping UK agriculture on the road to net zero

Before we delve deeper, it's important to understand the climate change basics, so let's look at those first.

What is The Greenhouse Effect?

It all starts with the sun. 30% of the solar energy that reaches Earth is reflected back into space[8] by things like clouds and ice. The other 70% makes it through to Earth, heating it up and making it habitable[9]. That heat is then radiated back in the form of infrared light, which gets absorbed by molecules in gases found in the earth's atmosphere and directed towards Earth again[10]. This game of energy, heat and gas ping-pong is known as the Greenhouse Effect.

Which are the greenhouse gases?

The earth's atmosphere contains several gases – the ones below are called the greenhouse gases[11].

- **Water Vapour (H_2O):** This is the main greenhouse gas. It responds to atmospheric temperature changes, and the more they rise, the more water vapour there is[12]
- **Nitrous Oxide (N_2O):** Often produced when fertiliser is used in soil cultivation but can also occur during biomass burning
- **Carbon Dioxide (CO_2):** Everything from our own breath to volcanic events can produce CO_2 emissions – but they're mainly caused by activities such as burning fossil fuels[13]
- **Methane (CH_4):** It can occur naturally through processes such as plant decay, but also from human activity, including burning natural gas, and livestock farming

So, what is net zero?

Simply put, net zero is when there's a balance between emissions produced, and emissions removed from the atmosphere.

These days it's not just governments who talk in terms of net zero. Many private organisations and brands have already set their own net zero targets, offsetting emissions involved in the production of their products.

Retailers such as Sainsbury's are aiming to get to net zero by 2040[14], with Tesco trying for 2035[15]. Last year, Aldi announced that they've already arrived, thanks to a large offsetting scheme[16].

Morrisons have taken a slightly different approach by focusing on their suppliers, and an ambition to be supplied only by net zero farms by 2030[17]. They're starting small, working with a select group of farms to create net zero models, which will then be shared with their 3,000 suppliers. The chain aims to offer UK consumers net zero eggs by as early as 2022, with net zero beef potentially hitting the shelves in 2025.

How will it affect you?

What sort of impact will these targets and market changes have on farmers? The short answer is carbon audits. We're already seeing retailers carry out regular audits to measure their suppliers' carbon footprints. Morrisons was one of the first, and we expect others to follow suit soon. The question is, will we start seeing contractual clauses from the supermarkets which demand proven annual emissions reductions?

What is climate change exactly?

The Met office defines it as the long-term change in the planet's weather systems and average temperatures.

Before the mid 1800s, for 11,000 years, the earth's average temperature was 14 degrees Celsius[18]. Previously, the average levels of carbon in the atmosphere were approximately 284 ppm (that's parts per million – a measurement used to describe the number of units of mass a contaminant has, per million units of total mass)[19]. Then, the industrial revolution arrived. With it came new machinery driven by fossil fuels, which greatly improved agriculture, and increased food supply. This all but ended famine in Europe, and led to unprecedented population growth.

There's little doubt that the 1800s marked the turning point, and since then, human activity has increased the earth's average temperature. It's risen by approximately one degree Celsius[20], and the level of carbon in the atmosphere has nearly doubled, with the highest level in human history recorded in 2019 at 412ppm[21]. According to Nasa, 2020 was the world's warmest year, narrowly beating 2016 temperatures[22]. The world's seven hottest years have all occurred since 2014, with the top ten all within the last ten years[23].

What effects does it have?

When a planet gets warmer – even by just a degree – it can have dramatic effects on the oceans and weather systems.

Oceans absorb 90% of the heat generated by human activity, causing them to expand and rise[24]. This process, known as thermal expansion, is thought to have contributed to approximately half of the increase in sea levels.

Put that alongside increased amounts of ice melting into seas around the world, and the sea levels keep on rising. Recent analysis from IMBIE (Ice Sheet Mass Balance Inter-comparison Exercise – a joint venture between the European Space Agency and Nasa) shows that levels of Antarctic and Greenland ice are declining six times faster than in the 1990s[25]. Mean sea levels have risen by over 19 centimetres since 1902[26]. These put anyone living within 100km of a coastline[27] (that's about 40% of the world's population) at significant risk.

Climate change has also been linked to the severity of weather events, resulting in extremes of temperature (both hot and cold), rainfall and sea levels[28]. It's important to add that exactly how much human activity influences events such as tropical storms is still being explored.

Longer-term, the effects of climate change will result in the mass movement of populations, as regions across the earth become uninhabitable. The World Bank has predicted that if temperatures and seas continue to rise at their current levels, over 143 million people could become climate migrants, escaping from crop failures and rising tides[29].

What does climate change mean for the UK?

We often hear about the global impacts of climate change, but how do they compare with what's happening here in the UK?

The answer is, it's a similar pattern. Our ten warmest years have all occurred since 2002[30]. Our winters are expected to become warmer and wetter, and summers drier and hotter[31]. Plus we're also likely to experience more events of heavy rainfall – seven of our ten wettest years have all been since 1998[32].

Like the rest of the world, we're getting more used to extreme weather events[33]. Heatwaves like those which took place during the summers of 2019 and 2020 are expected to happen more often.

In 2020, temperatures above 34 degrees Celsius were recorded somewhere in the UK for six consecutive days, with the highest recorded outside London being nearly 40 degrees.

Temperatures of 34 degrees have been recorded during seven of the last ten years, compared with only seven of the fifty years between 1961 and 2010[33]. At the other end of the spectrum, heavy rainfall, like that experienced in February 2020, where 237% more than the average level of rain fell, is now seven times more likely[34].

What risks to UK agriculture?

Physical risks

The met office predicts that by 2070[35]:

- Winters will be between 1 and 4.5 degrees warmer and 30% wetter
- Summers will be between 1 and 6 degrees warmer and 60% drier

Traditional crops may become ungrowable, new varieties will become commercially viable[35], but only for a while. As the temperatures rise, the difficulties of growing crops and farming livestock are likely to present more challenges than opportunities.

For example, farmers will have to cope with issues they haven't faced before. These include heat stress amongst herds, which cause lower fertility levels and milk yields[36] which impacts profitability. The cooler seasons will bring their own challenges, such as increased winter flooding, sometimes caused by rising sea levels[35].

Farmers will be forced to make difficult land management decisions to enable them to deal with more regular weather extremes.

Socio-political risks

Consumer dietary changes

UK consumers are becoming more conscious about how much meat they eat. In 2017, 50% of the population had tried meat-free products. By 2019, this had risen to 65%, with sales increasing by 40% between 2014 and 2019, according to Mintel[37].

In a 2019 survey called 'UK Food Trends: A Snapshot in Time', Lloyds Register found that 75% of consumers surveyed wanted supermarkets to only stock food from sustainable and ethical sources[38].

Supply chain expectations

The supply chain (retailers and suppliers) will always respond to the needs and wants of their customers. As we mentioned earlier, many of the UK's supermarket chains have already responded with net zero targets, and some now even audit their suppliers too. Within the next five to ten years, we could see all retailers requiring and adapting tax rules to disincentivise products with a high environmental impact.

Government legislation

As we approach the net zero target dates over the next few decades, it's likely that new legislation will be introduced to speed things up. This could come in the form of new policies, or amendments to existing laws on carbon and the environment and adapting tax rules to disincentivise products with a high environmental impact.

Agriculture is already seeing subsidies and support payments being linked to environmental targets as opposed to purely production.

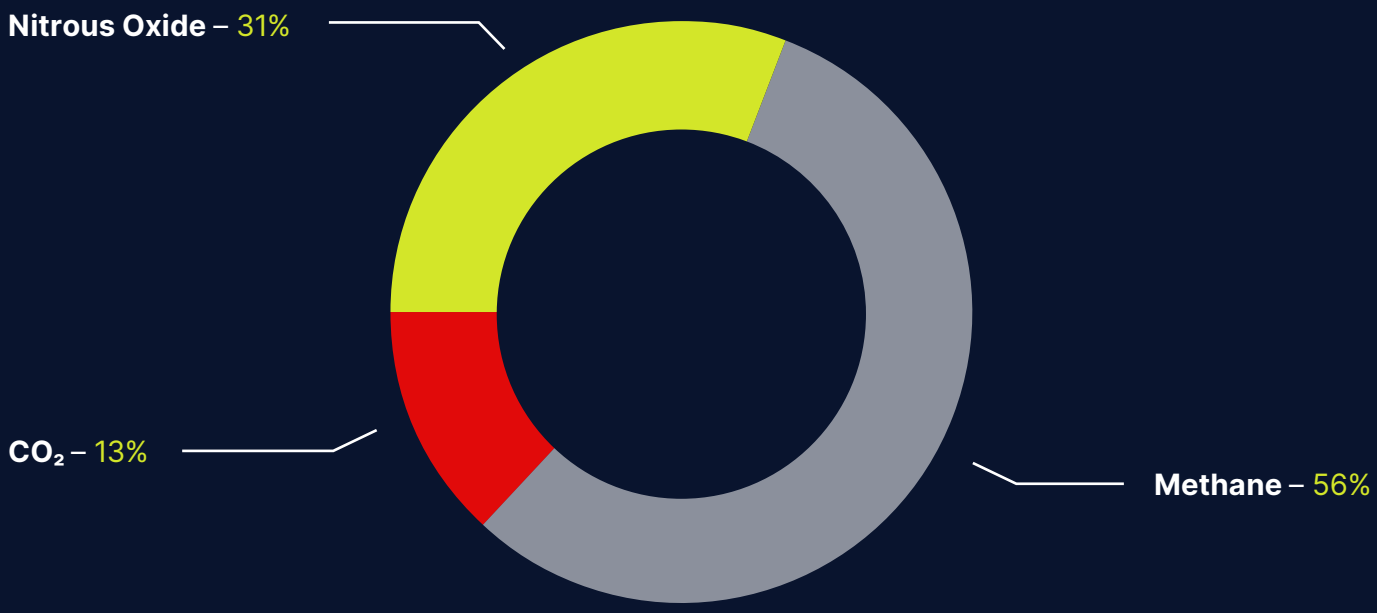
How is UK agriculture shaping up?

Farming is a hugely important industry in the UK, growing over 60% of the food the country consumes[40], employing approximately 500,000 people and contributing over £10 billion to the UK's economy[41].

The agricultural sector is key to the UK achieving net zero targets, both through the reduction of its own emissions, and land-use practices that can create carbon sinks (natural storage).

As the chart below shows, 56% of the sector's emissions are methane, 31% are nitrous oxide, and only 13% carbon dioxide. To meet the NFU's goal of net zero by 2040, it's likely that significant decarbonisation will be required.

Agricultural emissions breakdown



Although the sector has reduced its emissions over the past thirty years, agriculture is currently responsible for around 10% of the UK's total greenhouse gas emissions[41]. It accounts for 70% of nitrous oxide, 50% of methane, and 1% of UK carbon dioxide emissions. This works out at a cumulative total of 45.6 million tonnes of carbon dioxide equivalent ($MtCO_2e$).

The big guns: methane and nitrous oxide

In farming, the two gases which need to be reduced the most are nitrous oxide and methane.

- Nitrous oxide emissions are often produced by things like synthetic or inorganic fertiliser
- Methane comes from enteric fermentation, where it's broken down through digestion. Both ruminant and non-ruminant species produce methane, but cattle and sheep produce the most per unit of feed[42]
- The level of methane emissions can differ significantly depending on the manure management system

The UK is doing okay

It's important to recognise that UK agriculture is well-placed to meet its emissions targets.

For example, emissions from beef production are about half the global average[43]. Plus we're the fifth-lowest user of farm antibiotics across 31 European countries. Only Norway, Iceland, Sweden and Finland use fewer, and these countries enjoy the natural advantage of colder climates, which help prevent the spread of bacteria, and reduce the need for antibiotics[44].

Between 2014 and 2018, use of antibiotics on UK farms dropped by an impressive 53%[45].

Is methane misunderstood?

Hydroxyl oxidation says maybe

Methane is agriculture's biggest emission and is an extremely powerful greenhouse gas. When it's first released into the atmosphere, it can cause significant warming by trapping energy. However, it only stays there for around 10 to 13 years[46]. That's because it gets removed from the atmosphere, then re-used, through a process called hydroxyl oxidation.

Then there's the methane cycle

Livestock herds eat plants and grass which contain CO_2 that they have absorbed from the air around them. The livestock then break down the carbon in their stomachs and emit methane. While that methane is in the atmosphere, hydroxyl oxidation breaks it down into carbon[47].

Hydroxyl oxidation happens when the sun's energy breaks down the hydrogen and oxygen bonds in H_20 molecules contained in water vapour. The now broken-down molecules form and create hydroxyl radicals (OH). The OH molecules are unstable and try to stabilise themselves by adding molecules from the gases around them. This breaks down the molecular structure of potent gases such as methane or nitrous oxide and forms less harmful new structures such as H_2O or CO_2[48]. The newly created CO_2 is then re-used by plants and the process repeats.

Types of methane-biogenic

We've seen governments treat enteric methane and other greenhouse gases differently in their net zero strategies. Some are focusing on other methane sources, such as biogenic methane.

Biogenic methane is produced by plants and animals, and contains carbon already present in the atmosphere. When this methane is emitted it causes warming, but over time, because of hydroxyl oxidation, it returns to carbon. This means it doesn't contribute to the concentration of CO_2, as it was already in the atmosphere.

On the other hand, methane that comes from fossil fuels has often been stored underground for millennia and is not already in the atmosphere. As a result, methane released when fossil fuels are burned both increases warming, and adds to the concentration of CO_2[49].

Greenhouse gases – the influences & impacts

The influence that greenhouse gases have on climate change depends on three things:

1. The concentration of the gas in the atmosphere
2. How long the gas lasts (its lifetime)
3. How effective the gas is at trapping heat[50]

Climate policies need to cover a range of different gases and aerosols, which can all vary in the amount of heat they trap and the length of time they stay in the atmosphere. This means there's a need for a standardised way of measuring the equivalent impact of each gas. The most common way of working out carbon equivalents is by using what's called the GWP (Global Warming Potential). Read on and we'll take you through it.

What's GWP (Global Warming Potential)?

GWP is a way of comparing how much energy a tonne of a gas will absorb in comparison with a tonne of CO_2 often over a 100-year period (GWP100).

When you read a climate change report, you'll often see acronyms such as CO_2e or GWP100 used to demonstrate GWP. The 100-year variant of the GWP measure first appeared in the Kyoto Protocol and Paris Agreements.

Within GWP measurements, CO_2 has a measurement of 1, as it is the base unit of comparison. Although it has a shorter lifespan, due to its high heat absorption, methane has a measurement of 28 to 36. This has lead to the much-quoted statement that methane is 28 more times potent than CO_2[51]. Non-carbon emissions are measured by multiplying the volume of gas by its GWP100 number. For example, a tonne of methane equates to 28 tonnes of carbon dioxide equivalent.

What the critics say

Although GWP is widely used, many argue that it's oversimplified and ignores key differences between gases. For example, if a tonne of methane was to enter the atmosphere, it would cause initial warming which would then pretty well disappear over 10 to 13 years[52]. By comparison, the GWP multiple of methane says it apparently equates to 28 tonnes of carbon, which would cause warming for hundreds of years.

For reasons like this, some say the figures don't add up, and that you can't equate one gas to another in that way[52]. In the example we gave, GWP treats methane as a stock gas (one that accumulates) rather than a flow gas (one that is short-lived)[52].

Nevertheless, academics, scientists and policy makers are in no doubt that rising methane emissions can cause significant warming. In response to the European Commission, leading scientists from Oxford University's Climate Dynamics Department have even suggested that the GWP100 measure understates the effects of new methane sources.

On the other hand, they have acknowledged that when methane levels are stable, GWP100 overestimates its warming by a factor of four. This could mean that stable methane levels might only cause 25% of the warming that GWP100 says it would[53].

Oxford's scientists also argue that one of GWP's biggest flaws is that it can't be used to accurately assess temperature-related goals, mainly because of the differences in emissions rates mentioned above.

In other words, although GWP quantifies gases as CO_2 equivalents, these scientists are questioning what this means in terms of their equivalent warming, and actual effect on temperatures?

In a 2019 study, the group proposed an alternative to GWP, called GWP*. This was to better account for the differences between short and long-lived pollutants and their effects on warming[54]. It also makes it easier to calculate the equivalent warming effects of the gases, based on the simple idea that if global targets are temperature-focused, (eg: like the Paris Climate Agreement's aim of keeping rising temperatures below two degrees) measurement systems should be too[55].

This modified GWP measurement is surely a step forward, as it changes the way methane emissions are considered, which could have significant implications for farming.

However you measure them, though, increases in methane will cause warming of the planet[56]. This is not great news for ruminant farmers, who face the challenge of providing for a growing population, while trying to maintain stable levels of methane emissions.

Currently, across the UK, levels of cattle have been relatively stable for the past ten years. 2019 figures of approximately 9.4 million show the UK's cattle herd is the smallest it has been since 1984[56].

How can farmers reduce emissions?

Here are seven areas to look at:

1. Carbon auditing

A carbon audit helps you understand where your emissions are coming from, and where changes could be made to reduce them.

2. Soil health and tree planting

Soils are one of the world's largest carbon sinks, yet they are often overlooked. Improving your soil health could increase carbon storage, not to mention improve crop quality and yields, as well as reduce the need for fertiliser.

3. Manure management

One of the best ways to improve soil health and reduce fertiliser costs is through an effective manure management plan. Bought fertiliser can then be used as a top-up to supply additional nutrients that manures can't.

4. Agri tech and data

Smart tech can reduce both costs and emissions – by using GPS-enabled precision fertilising, for example. The arrival of precision agriculture has started the sector on a path towards data-driven farming, delivering maximum efficiency.

5. Machinery management

While the use of electric and methane-powered tractors might still be a few years away, there are several simple steps you can take now to improve the efficiency and fuel consumption of farm machinery.

6. Energy management

There's nothing new about using renewables to achieve net zero. Now's the time to think about how to use renewable sources beyond the standard supply of on farm or grid electricity.

7. Livestock management

Careful management of livestock housing, their health and diets is really important in reducing emissions. There are already several feed additives available which can help – and others, like seaweed, which are up for discussion.

The industry experts: Carbon Metrics

To help us provide you with useful insights, we've partnered with carbon management consultancy, Carbon Metrics. They analyse carbon audits to help businesses identify how they can become more environmentally and commercially sustainable.

Simon Haley established Carbon Metrics in the summer of 2020. It came from his shared passion for creating a better understanding between the environmental footprint of a business, and how it influences its financial decisions.

Where to start? Carbon audits

To understand where you currently are on the road to net zero, the best place to start is with a carbon audit. This helps you set a benchmark, so you can compare your farm with others of a similar size or type, both now and in the future.

If it sounds daunting, don't worry. Carbon auditing tools make it easy to find out the equivalent emissions from your farm. There are lots of tools available, no matter what type of farm you have and where it is. The most popular tools are Cool Farm and AgreCalc, but there's no shortage of alternatives.

What do they measure?

- Use of fuels and electricity
- Materials, machinery and buildings
- Cropping and fertility
- Livestock
- Fertiliser use and sprays
- Waste and recycling

An audit will also identify actions you can take to reduce your farm's carbon output, and increase efficiency – reducing both emissions and costs.

How effective are they?

After a carbon audit, it's reckoned that most farms can reduce carbon by around 10 to 15% by making simple changes, such as sampling manure and soils, which should reduce the need for fertiliser. A further 10 to 15% of reductions can be made by investing in new machinery, while reductions of between 30 to 40% will require longer-term measures[57], such as the electrification of vehicles.

A carbon audit is a great first step, but think of it as the beginning of the journey. Carbon output is a bit like a crop, in that it needs careful management, nurturing and monitoring.

Carrying out carbon audits annually can help identify trends across the farm, and make it easier to keep an eye on your progress towards your emissions goals. By building emissions data, you'll be able to see which areas are performing well, as well as those you might have overlooked since the previous audit.

Carbon Metrics Insight: building data

"At our last count there were over 60 different types of carbon auditing tools. When selecting an auditing tool, it's best to choose one that uses recognised IPCC calculations, and looks at the emissions cycle of gases past 2050.

If you've decided to carry out a carbon audit, it's worthwhile doing two, using different tools. As each tool has its own calculations and nuances, the combined data gathered can help verify initial results, and build up a complete picture of farm emissions.

A carbon audit is one of the steps towards building up the right type of farm data. The idea behind data management is to take complicated inputs and turn them into simple outputs. Power lies in data, and in predicting performance and anticipating risk. More efficient use of data is said to increase profitability levels by up to 25%.

When you think of data as an asset, it soon becomes a worthwhile and valuable one. A better understanding of data's financial worth could be a factor in increasing the value of your land and natural capital. When datasets are used and analysed correctly, they can provide invaluable information on how your business operates.

Looking at it retrospectively, this information, and the transfer of historical data, can be really useful to a landowner or investor when planning the future of their business".

Sequestering carbon: don't forget soil (and trees)

Plants and trees absorb CO_2 from the atmosphere. They turn it into sugars which help grow their stems, leaves, roots and trunks[58]. Some carbon makes its way into the soil, which enriches it. When soil acts as a sink (or store), it stabilises the CO_2.

While sequestration (the removal of CO_2 via plants and micro-organisms) through forestry gets a lot of media attention, soils are often overlooked – but they're one of the most important carbon storage methods available.

To back that up, here are some soil facts:

- The top metre of the soil contains three times as much carbon as the atmosphere[59]
- Soil is the second biggest carbon sink behind our oceans
- The ONS (Office For National Statistics) estimates that 94% of the UK's biocarbon stocks is contained within soils[60]
- Improving a farm's organic matter leads to improved soil structure, increased carbon storage and healthier crops[61]

Soil loss

When trying to improve agricultural soil health, farmers face two challenges – soil compaction, and erosion. Farm machinery is one of the main causes of soil compaction. Compacted soils are more likely to become waterlogged, with run-off causing a loss of nutrients. This means doubling the amount of fertiliser that needs to be used.

Extensive erosion can also happen when the soil takes in water, but wind and loss during harvest are also to blame. It's worth remembering a bare slope can erode nearly a thousand times faster than one covered in vegetation. Unfortunately, as the scale and size of farmland has increased, the length of hedgerows has decreased. This leaves large areas of topsoil exposed to wind erosion[62].

Carbon Metrics Insight: get to know your soil

"There are several tests that can be used to check soil health. Carrying out a 'loss on ignition' test helps to measure the amount of organic content in your soils. As the programs used in auditing use averages to work out soil sequestration (the removal of CO_2 via plants and micro-organisms), this action is key in finding out whether soil carbon is being built up. It needs to be done annually to show the soil carbon build up. Plus it's important to carry out soil sampling to find out the fertility of the soil, by analysing the amount of phosphate, potash and magnesium in it. Once this is known, it's easier to decide which nutrients to add, by using the correct mix of fertiliser. This both increases the health of the soil, and may decrease the use of unnecessary fertilisers".

Soils and their health: regenerative agriculture

There's been a lot of debate about regenerative agriculture amongst farmers across the world. Some buy in to it, while others are sceptical. The idea behind regenerative agriculture is to put soil health at the heart of farm management.

Much of what we've already looked at is key to regenerative agriculture. In addition, techniques such as minimum tillage are used to reduce soil compaction and loss, as well as to reduce the amount of stored CO_2 being released from disturbed top soil[63].

To improve soil health, try these:

- Minimise soil disturbance
- Grow cover crops where possible to prevent top soil loss
- Locate hedgerows or trees where they can better shield the soil[64]
- Test soils to measure current health and benchmark for the future
- Analyse soil nutrient requirements. Use soil testing to find the correct balance of fertiliser, and to eliminate the use of unnecessary compounds
- Add natural manures or biochar (soil conditioner) to land

Sequestration through trees and hedgerows

As well as acting as carbon sinks, planting trees offers several other benefits. They can:

- Act as windbreaks, protecting against top soil loss
- Offer shelter for animals (e.g. during a heatwave)
- Protect against drought or flooding[64]
- The sequestration of land for forestry will require careful consideration and planning

Carbon Metrics Insight: do trees fit into your strategy?

“Before thinking about tree-planting strategies, it’s important to work out how they fit into your long-term farm management and net zero plan.

Trees can be a worthwhile addition across the holding, particularly if certain areas of land are less productive. That said, it’s important to recognise that converting arable land or grassland into woodland as part of the overall business sustainability plan can be less beneficial in the long-term. Land use change needs to be at the heart of any land management strategy, and it’s worthwhile asking yourself about your overall goal and where gains can be made. For example, are trees being planted to help drive the farms longer-term net zero strategy, or for a potential ‘quick fix’ income stream through carbon credits?”

Reducing inputs, maximising outputs

One of the most effective ways to reduce carbon emissions is to increase your farm’s efficiency. Sometimes you can do this without adding any inputs, while still lowering the volume of CO_2e per KG of product leaving the farm.

The four areas to look at are:

- Manure management
- Machine management
- Energy management
- Livestock management

Manure management

Managing manure effectively is an excellent way to reduce fertiliser costs, and improve the organic content of soils.

The first thing to think about is storage. In short, you need to have enough available to make sure that manure and/or slurry are accessible on demand. It's important to keep water away from the stores to prevent dilution and contamination[65]. We expect methods of slurry storage to change over the coming years, as DEFRA introduce new regulations, such as the requirement for slurry stores to be covered[66].

When using manures as fertiliser, an optional first step is to measure their nutrient content to make sure it's right for your soil. While standard nutrient manures are widely available, their actual nutrient content may differ from farm to farm, depending on things like feed and bedding.

When using organic manures and fertilisers together, it's important to consider soil requirements and prioritise fields with poor soil conditions[67]. This is where sampling and testing soils come in handy. You can then buy fertiliser to top-up the nutrient levels where needed. It's best to apply manures when crops need the most nutrients – usually in late winter, spring and summer[65].

It's vital to take weather conditions into consideration. This should minimise the risk of losing unused nutrients to run-off, as well as the chance of water pollution.

Whether you're using solid or liquid manures, they should always be spread evenly[67]. The best way to do this is by using rear discharge spreaders – although other spreading machines have their benefits. For example, machinery with injection capabilities reduces the risk of contamination and nutrient loss, while umbilical systems minimise the chance of soil compaction[65].

Utilising agri-tech and data

Recent tech developments have greatly increased the accuracy of spreading. For example, GPS-enabled systems can be used to reduce the amount of fuel, fertiliser and time required to deliver nutrients to crops.

Other precision techniques such as yield mapping, variable rate fertiliser application, and soil mapping can also be integrated to increase efficiency.

It's not just arable farms that are benefitting from technology. There are now livestock sensors that can monitor feeding and health, plus medicine dosages can be individually adjusted to maximise yield and prevent disease.

All in all, tech is enabling a new data-driven approach to farm management. Precision agriculture has arrived.

Carbon Metrics Insight: it's going to be all about data

"IoT (Internet of Things) represents the connection of objects and places, remotely and wirelessly. This means it will be possible to manage farms, property, land, and estates with an extremely high level of accuracy, without physically being there. IoT takes meaning from the physical world, such as cattle tracking, to enhance intelligence and decision-making.

Soon, we'll be seeing more and more devices using sensors to collect data which can provide farmers with a wealth of information about their resources.

Sensors on machinery and equipment, as well as in the ground, will provide remarkable new benefits. For example, arable farmers will be able to monitor soil health (moisture and/or temperature). Livestock farmers will receive alerts when gates are left open, water troughs need filling up, fence voltages fall too low, or a bore hole pump fails.

As farmers adopt a data-driven approach, it will drive an evolution from precision to predictive agriculture.

Data will soon be at the heart of everything a business does, and more businesses will have to take a data-driven approach to decision-making. It's important that farmers take the bull by the horns and use these new data sources to their full potential.

Making sense of complex information will soon be an art form. By becoming data experts, farmers will be instrumental in the creation of better processes and systems.

Managing machinery

Here are a few tips on how to keep your machinery running efficiently:

Set tyre pressures correctly

This simple step reduces fuel consumption on any vehicle, but there are also extra benefits for farm vehicles. For example, when working in a field, lowering tyre pressures can result in a lower track depth[68]. Lower pressures also mean the tyre spreads out, which distributes the weight of the tractor over more soil, so there's less soil compaction. When driving on roads, increasing tyre pressures reduces the tyre's surface area, which minimises road resistance and reduces fuel consumption[69].

Train your operators

It's not just your machinery that you want to be working efficiently – those who are operating it need to be too. Poor working practices like over-revving, incorrect gear selection or insufficient technical knowledge all play their part in reducing efficiency and fuel consumption.

Match the machinery to the tractor

Getting this right (or wrong) can either reduce or increase fuel consumption and general wear and tear. If machinery is too large for a tractor, it will reduce field speed and efficiency. Overloading tractors also puts more strain on them, which can lead to damage and more frequent repairs. On the other hand, if a tractor is too big for the machinery, fuel consumption is unnecessarily increased, as it burns through more fuel than a smaller tractor would[70].

A good way to make sure you're using the correct size of machinery, is to compare towing speeds with the manufacture's recommendations.

Energy management

About 40% of UK farmers generate some form of renewable energy – either from the sun, wind, or farm waste products. This energy meets 10% of the UK's electricity requirements[71]. Less resource intensive methods of generating renewable energy come from sources such as solar panels, wind turbines and ground source heat pumps, methods that have all become synonymous with the move towards renewable energy.

Alternative renewables

As well as solar panels and turbines, there are other more resource-intensive sources of renewables. These include anaerobic digestion (AD) plants (anaerobic simply means 'without air'). Anaerobic digestion breaks down animal and plant waste in a large sealed container. Micro-organisms digest the waste and produce a methane-rich gas which can be used to generate power or heat[72]. Many farms could quite easily build AD plants, as long as the farm is big enough to generate enough waste. Smaller farms could form cooperatives, each providing their own waste[73].

Closing the loop?

Farms can play an important role in reducing fuel consumption, by generating and storing renewable electricity and methane-rich gas. Already, companies like New Holland and John Deere have unveiled concepts for methane and battery-powered tractors. Once these and other renewably powered machines are commercially viable, they could virtually eliminate farms' CO_2 output, as well as deliver energy independence[74] [75].

Payback and feasibility

One question is, which renewable(s) should a farmer choose to generate? The answer is to treat renewable energy like any other investment decision. Look at the initial cost and payback period, as well as which renewable is the best fit for the type and location of your farm. The return on investment will depend on a number of variables, especially how productive the chosen renewable is. For this reason, it's worth considering a renewable energy feasibility study before you jump in.

Carbon Metrics Insight: fully utilising renewables

"Many farms also use the energy they generate to power their own holdings. However, when reviewing or creating net zero strategies, regardless of the source of energy, it's important to consider how the power generated can be used in the most efficient way. We recently carried out an audit for a farm with solar panels that supplied electricity to the farm and the National Grid. We recommended several areas where the energy created could be put to further use.

For example, if a robotic feeding system was used, it would save on tractor fuel as the system would run on electricity. Further savings could be made by using the electricity from the panels to run small electric vehicles, such as electric quads or telehandlers.

Although requiring significant investment, this would increase efficiency and reduce fuel consumption, as well as lower fuel costs, and crucially, the volume of the farm's CO_2. It's important to consider the full potential of renewables and review which areas of the farm could use them most effectively".

Managing livestock

The wellbeing of livestock plays an important role in reducing emissions. The healthier, more fertile and high yielding they are, the better.

Diet

Reducing methane emissions by altering livestock diets is nothing new. Stories of additives such as seaweed have been in the farming press for the past ten years or so[76]. While there are lots of studies analysing how additives may help in the longer term, it's important to stress that there are already numerous products available today. These include several Carbon Trust-approved products from brands like Harbro and Alltech[77] [78].

Livestock housing

The best way to increase livestock yields without having to increase feed is to improve their living conditions. Efficient ventilation can prevent pathogens and reduce the chance of disease. Lighting levels also significantly affect productivity. A study from the University of Kentucky showed that providing cattle with 16 hours of light and 8 hours of darkness increased milk yields by 7%[79].

Gene editing

Looking towards the future, research has shown that altering the methane producing microbes within the guts of livestock can reduce the amount of methane emitted.

Where to find support

Now the UK has left the EU, many government-backed support and incentive schemes are changing. The good news is that if you're thinking about improving your farm's levels of efficiency and emissions, there are still plenty of options available.

We've picked out some schemes from DEFRA's publication 'Farming is Changing', which may provide you with a potential source of funding[66].

Environmental Land Management

The Environmental Land Management offer will be the new way for farmers and land managers to be paid for delivering things like:

- Clean water and air
- Protection from environmental hazards
- Reduction of and adaption to climate change

The Environmental Land Management offer will cover three key areas:

- Sustainable Farming Incentive (SFI): The SFI will aim to pay for environmentally sustainable land management actions
- Local Nature Recovery: The Local Nature Recovery will aim to pay farmers for actions that support local nature recovery and local environmental practices
- Landscape Recovery: Through bespoke arrangement, Landscape Recovery will aim to provide agreements for long-term land use change projects

Countryside Stewardship

The current Countryside Stewardship scheme will be available until 2024, and from now until then, the emphasis will be on improving on air quality.

Farmers in Protected Landscapes

Funding will be made available for farms located in Protected Landscapes to diversify incomes and prepare for Environmental Land Management.

Tree Health

Starting in 2024, this scheme will replace Countryside Stewardship Woodland Capital Tree Health Restoration and will provide support for felling and the treatment of disease.

Woodland Creation Support

There are numerous schemes available to help farmers enlarge and protect forests and woodlands.

Here are some of them:

- Woodland Creation Planning Grant
- Countryside Stewardship
- Woodland Carbon Fund
- Woodland Carbon Guarantee

For further info, see the Forestry Commission's overview of Woodland Funding.

Slurry Investment

Beginning in 2022, this scheme aims to support farmers investing in new slurry stores that exceed current regulatory standards and protect them against future changes in the regulations. New regulations will also be introduced mandating the covering of slurry stores.

Farming Investment Fund

Under the Farming Investment Fund, funding will be provided for equipment, technology and infrastructure that improves farm productivity and offers environmental benefits.

The fund will be split into lower and higher value investments, with funding available for a percentage of the overall cost. These could cover investments such as robotic or automation technology.

Food for thought

Premium or standard?

With many retailers becoming more carbon-conscious, and Morrisons announcing their first net zero lines, the change both in climate and eating habits is feeding the national conversation.

As with any conversation, there are questions being asked. Like is there more money to be made from net zero product lines, or will legislation require that all products become net zero at a certain point? If that point isn't until 2050, are there opportunities for farmers who are already operating at near net zero, to capitalise on this in the meantime?

UK agriculture has some of the highest environmental and welfare standards in the world. Mix that with the increase in public concern for animal welfare and more sustainable diets, and it throws up another question. Could net zero become something that the agricultural sector moves to capitalise on, not just over the next few decades, but during the next five to ten years?

Carbon credit trading

As net zero target dates approach, carbon trading will start to increase as organisations make a last-minute dash to offset their emissions.

While some are lagging behind, many have already begun buying large quantities of carbon credits. This is why the state of the carbon trading market both now and in the future is relevant to the agricultural sector, especially as over 70% of land across the UK is farmland, and by repurposing, can have the potential to deliver carbon credits for trading.

What we know so far:

1. At the present time there are just two recognised accreditation schemes enabling carbon units to be traded in recognised markets – the UK Woodland Carbon Code, and the Peatland Code.
2. In the medium term, we're awaiting the roll-out of a post-Brexit UK carbon trading system, which will be known as UK ETS (Environment Trading Scheme)
3. Given the lack of schemes providing accredited carbon units for trading, several businesses and organisations have invested directly in projects which can identify carbon to offset their own emissions
4. As farmers consider the potential of selling surplus carbon credits, it's important they get advice from professionals and trade bodies. However, it's worth thinking about how things may play out, particularly as the demand for carbon credits will quickly grow, as the available land shrinks

The importance of marginal gains on the journey to net zero

With retailers now setting their own ambitious targets, the journey towards net zero looks set to accelerate. Initiatives such as tree sequestration, feed additives, gene editing and whatever comes next will all have a part to play, but there's no silver bullet solution.

Instead, farmers will need to take an all-encompassing approach to farm management. One that focuses on making marginal gains from all parts of the farm – every building, piece of machinery, hectare of land and head of livestock – no matter how small or large their contribution.

Who's behind this report?

Brian Richardson, UK Head of Agriculture, CYBG PLC

Brian has spent his career in agribusiness. He brings a wealth of experience with him to lead the bank's agricultural team, as well as support Virgin Money's customers during a period of rapid change for the farming sector.

Simon Hayley, Founder, Carbon Metrics

Simon Haley has a decade of consultancy experience, focused on strategic business appraisal and recommendations. He specialises in agricultural policy and rural development, as well as delivering training sessions for farmers and other professionals. He builds out carbon management plans through data interpretation to achieve sustainable outcomes linked with financial analysis.

Carbon Metrics

Carbon Metrics is an agricultural and environmental consultancy firm offering bespoke solutions to rural sustainability challenges. At Carbon Metrics we use data-driven solutions to help clients benefit from increases in business efficiency, whilst maximising the potential from their carbon opportunities. We offer dedicated carbon management plans for farms and estates that identify key areas of business inefficiencies and provide robust mitigation measures to reduce their carbon footprint.

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